Use of irradiation to increase shelf-life of minced-meat products

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In the food service industry in family catering, too, ready made minced meat products have a large share in the menu. The preparation, storability and microbiological quality of these products cause considerable problems for the consumers. The refrigerated storage time of minced meat is very short. In most countries, the sales of such products is to be effected within 1 or 2 days.

To diminish the large energy demand of refrigerated storage, we examined the possibility of the combination of irradiation and refrigerated storage in increasing the storage capacity of minced meat. Knowing that ionizing radiation can kill microbes and inhibit microbial activity, we tried to apply irradiation to improve the microbiological quality of ready-to-serve minced meat products, and thus to increase storage time.

MATERIALS AND METHODS

We used pork meat for the experiments. We added irradiated spices /5 kGy/ to the chopped meat in the proportion of 1 %, and mixed it carefully with the necessary quantity of other ingredients. Then we made balls of 35-45 grams, packed in aluminium foil. The applied radiation doses were 0.5, 1, 1.5 and 2 kGy, respectively. Irradiation was carried out in an RH-gamma-30 /^{60}Co/ laboratory source. During the irradiation the temperature was 24-28°C.

The experimental materials were stored at the temperature of 4°C. As the shelf life of the untreated sample is very short, for the organoleptic test, the untreated samples were stored at the temperature of -18°C, as an absolute control. We watched the development of slight off-odour and other changes indicating deterioration in order to determine the storage time. The number of mesophilic aerobic /30°C/, psychrotolerant /10°C/ and proteolytic microbes was determined as a function of storage time, according to the MPN or pour-plate method. We examined the changes in the TBA number /7/. In case of fried minced meat, we carried out organoleptic tests by the scoring and ranking method by 9-11 panelists /5/.

According to treatment level, the number of parallels varied between 50-100. The experiments were repeated six times.

RESULTS

Spoilage was determined as a function of the irradiation dose and storage time. The appearance of slight off-odour was regarded as the threshold value of deterioration /3./ /Fig.1./

We established that, in the dose range examined, the optimum was 2 kGy. Depending on the initial microbial load, the storage time was 4-6 days /spoilage level 5 %/, in the case of untreated samples in the case of the ones treated with 2 kGy, it was 12-14 days.

From the spoilage curves, we determined the time required for reaching a spoilage level of 5 % of the samples /shelf-life/ /Fig.2./

Based on the 5 % spoilage level, it could be established compared with untreated samples stored at the temperature of 4°C, doses of 2 kGy more than doubled shelf-life.

Microbiological examinations properly support these statements. The number of mesophilic aerobic microorganisms diminished by the order of magnitude of 2-3, the psychrotolerants were more sensitive, therefore their number diminished by 3 orders of magnitude /Fig.3./

After irradiation, the microbiological state gets stabilized for different periods, depending on the applied dose; then there is a slow increase in the number of microbes.

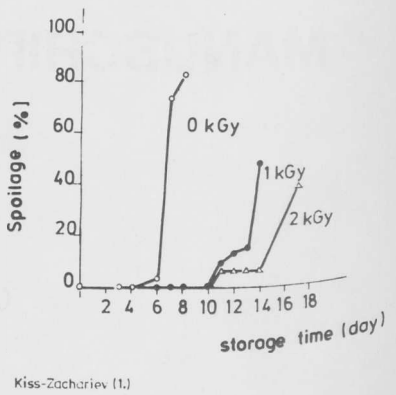

Figure 1.

Spoilage of unirradiated and irradiated minced meat as a function of the storage time at 4°C

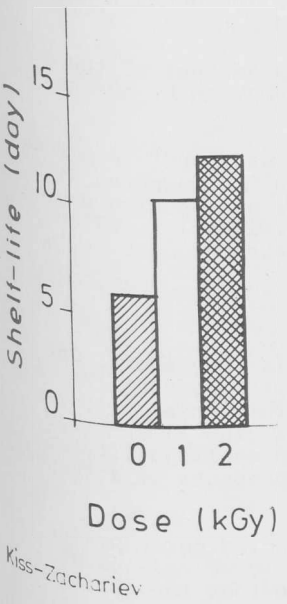

Figure 2.

Shelf-life of unirradiated and irradiated minced meat at 5 % spoilage level.

Consequently, the growth rate of the microbes that survive the treatment also slows down. The number of proteolytic microbes decreased by 3-4 orders of magnitude, but there was no change in their number during the storage time.

The microbiological quality of the product influences, of course, the organoleptic quality, too.

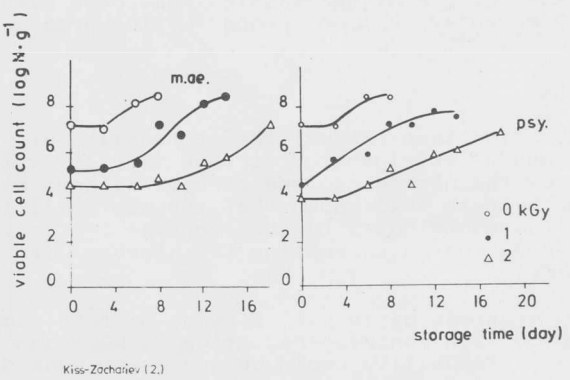

Figure 3.

Survival of mesophilic and cold tolerant microbes of the minced meat as a function of irradiation dose and storage time.

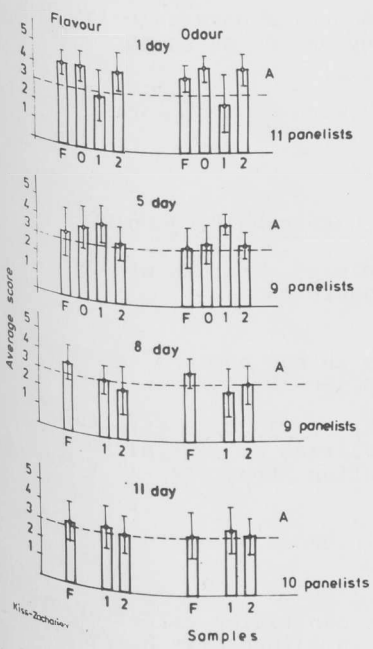

Figure 4.

Organoleptic evaluation of unirradiated /frozen stored, -18°C = F and cool stored 4°C = 0/ and irradiated /1 kGy = 1, 2 kGy = 2/ minced meat samples /average score and standard deviation of flavour and odour/ as a function of the storage time /A = acceptability level/

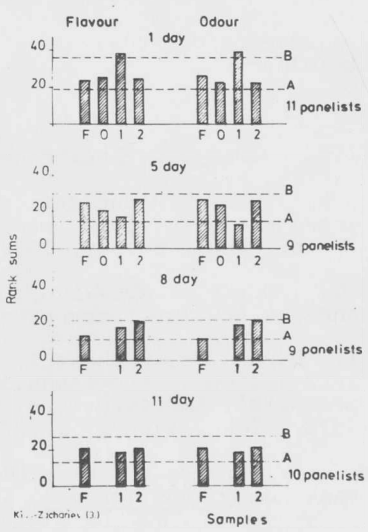

Figure 5.

Organoleptic evaluation of unirradiated /frozen stored, -18°C = F and cool stored, 4°C = 0/ and irradiated /1 kGy = 1, 2 kGy = 2/ minced meat samples /rank sums of flavour and odour/ as a function of storage time /rank sums between A and B do not differ significantly at 95 per cent of probability level/

The following figures /Figures 4. and 5./ indicate the results gained by organoleptic testing /taste and odour analysis/ of the fried minced meat balls. The average scores are illustrated as a function of treatment and storage time /Fig.4./.

The quality of the sample treated with a dose of 2 kGy is the same as that of the one stored under refrigeration. These results are confirmed by data computed by the ranking method /Fig.5./.

The TBA-number, characterising rancidity process of fats, was not different from that of the untreated sample right after irradiation /fat content 13-16 %/. Compared with the sample stored at the temperature of -18°C /TBA = 3.5 mg kg^{-1}/, on the 13th day of storage, that number of the sample irradiated with 2 kGy was significantly smaller /TBA = 1.7 mg kg^{-1}/. But on account of the great scatter, this statement must be further confirmed.

DISCUSSION

At refrigeration temperature, the storability of raw minced meat is very short. The energy demand of refrigarated storage is relatively large: 90 $kWh.t^{-1}$, and at the same time many of the microorganisms survive without being damaged by this relatively low temperature. It is well known that the microbial load of spices is high /1.,2.,4.,6.,8./, and this, too contributes to the decrease in time. We examined the applicability of ionizing radiation in increasing the storage life of minced meat products at a temperature of 4°C.

The minced meat was mixed with a spice mixture /paprika, pepper, dried onion powder, etc./ treated with ionizing radiation /5 kGy/ and being thus of a lower cell count. In this way, storability could be increased considerably. We found that the optimum dose of 2 kGy at least doubled the storability at 4°C of minced pork meat mixed with spices as compared to the untreated sample. The application of higher doses was not proportionate to the increase of storage time in view of economic considerations. Our recent studies have revealed that storage time can thus be increased up to 16-20 days.

Increase in storability can be explained by a decrease of 2-3 orders of magnitude in microbic load, by its entire elimination on the one hand, while by an inhibition of the metabolic processes of the surviving microorganisms. The organoleptic qualities of samples irradiated by 2 kGy do not differ from that of products kept in frozen. Further tests are needed to select the best packaging material and to reproduce the results under pilot-scale and plant-scale conditions. According to preliminary calculations, small doses of irradiation /radurization/ yield 38 % energy saving as compared to refrigeration.

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